

**Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, DC 20554**

In the Matter of

Unlicensed Operation in the TV Broadcast  
Bands

ET Docket No. 04-186

Additional Spectrum for Unlicensed  
Devices Below 900 MHz and in the 3 GHz  
Band

ET Docket No. 02-380

**REPLY COMMENTS OF MOTOROLA, INC.**

Steve B. Sharkey  
Director, Spectrum and Standards  
Strategy  
1350 I Street, NW, Suite 400  
Washington, DC 20005-3305  
202 371-6953

Robert D. Kubik, Ph. D.  
Manager, Spectrum and Regulatory  
Policy  
1350 I Street, NW, Suite 400  
Washington, DC 20005-3305  
202 371-6940

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## **Summary**

Motorola supports the FCC's intentions to allow unlicensed devices to use most of the broadcast television spectrum as such use would provide additional resources to realize seamless mobility for wireless devices. In so doing, the FCC must ensure that all radio services with a higher allocation status must be protected and not degraded by this action. Sharing issues in bands also used by public safety are the most sensitive and Motorola therefore recommends that the Commission should exclude unlicensed operations from TV channels 14-20 and TV channels 52 and above.

Motorola supports the use of location technology and beacons/control signals to ensure that unlicensed devices operate in areas removed from protected incumbent operations. Motorola agrees with those commenters that argue the FCC should not adopt a specific location-based technology and that the proposed 10 meter accuracy requirement is overly precise. Motorola urges the Commission to require that any location technology used for the purpose of locating areas in which unlicensed devices can operate must have an accuracy of 100 meters.

Motorola reminds the FCC on the need to establish out-of-band emissions requirements that fully protect incumbent operations. Motorola's studies demonstrate that the proposed requirements based on Section 15.209 are inadequate by at least 35 dB when considering worst-case deployment scenarios. While the Commission must decide whether it needs to protect against worst-case scenarios that might be extremely rare in practice, Motorola's analysis shows

that additional protection should be considered. Motorola also reiterates its recommendation that mobile and portable devices should be subject to adjacent channel interference standards.

While Motorola supports the use of professional installation, geolocation techniques and control signal beacons to ensure that unlicensed devices are not deployed in areas where they might cause interference, there are fundamental issues that remain to be addressed before spectrum sensing can be relied upon as an interference-mitigation technique.

Motorola continues to urge the FCC to consider allowing professionally installed, higher-powered unlicensed fixed operations of up to 25 W in rural and remote areas provided that such operations comply with all interference protection requirements of the licensed services. Allowing higher powered devices will facilitate the deployment of broadband services to rural and remote areas by reducing the costs for the required infrastructure.

While Motorola shares Microsoft's concern about a proliferation of unfriendly or incompatible devices, the Commission should not regulate compliance with a particular interoperability standard so as to not rule out innovative uses of the band.

The Commission should reject the comments submitted by Harris Corporation to require unlicensed devices to automatically transmit a unique identification signal at least every 30 seconds. Assuming that equipment designs pass this threshold test, requiring devices to send automatic identifications every 30 seconds is regulatory overkill and would result in inefficient

spectrum use as millions of identifications for properly operating systems would be transmitted every day.

Motorola believes that the manufacturers of wireless microphones have made a strong case that such devices are threatened by widespread unlicensed uses if appropriate safeguards are not adopted. A solution that involves the reservation of TV channels for wireless microphones where unlicensed devices would be prohibited appears to be a realistic resolution for the routine use of these devices.

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Motorola, Inc. (“Motorola”), respectfully replies to the comments submitted in response to the FCC’s Notice of Proposed Rulemaking in the above-referenced proceedings.<sup>1</sup>

**I. INTRODUCTION AND SUMMARY.**

The NPRM seeks ways to promote the use of the TV broadcast bands by unlicensed devices while ensuring that incumbent operations are not impacted. In so doing, the Commission sought comments on the types of unlicensed devices that could be accommodated.<sup>2</sup> To ensure that no harmful interference to authorized users of the spectrum will occur, the Commission sought additional comment on several alternative methods for identifying unused TV channels, including approaches that would: 1) allow existing television and/or radio stations to transmit information on TV channel availability directly to an unlicensed device; 2) employ geo-location

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<sup>1</sup> See FCC 04-133, rel. May 25, 2004, (“NPRM”).

<sup>2</sup> *Id.* at ¶14.

technologies such as the Global Positioning Satellite (GPS) system; or 3) employ spectrum sensing techniques that would determine if the signals of authorized TV stations are present in an area.<sup>3</sup>

In its opening comments, Motorola indicated its support for the Commission's approach to promote use of the TV broadcast bands by unlicensed devices on most channels below channel 52 while ensuring that incumbent operations are not impacted.<sup>4</sup> While agreeing that unlicensed device access to unused TV broadcast channels would provide additional resources to realize seamless mobility for wireless devices, Motorola expressed concern on whether measures can be developed to protect public safety and other land mobile services operating on TV channels 14-20 in several major markets across the country. Accordingly, Motorola urged the Commission to prohibit unlicensed operations at 470-512 MHz to avoid any negative impact to the future growth of critical public safety services and other mission critical private wireless operations.<sup>5</sup>

Motorola agreed that control signal transmission and geolocation are acceptable mechanisms for identifying open channels for unlicensed operations. However, Motorola stated that spectrum sensing techniques are promising but unproven.<sup>6</sup> Finally, Motorola provided the Commission with several analyses based on the technical parameters proposed in the NPRM and

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<sup>3</sup> *Id.* at 2.

<sup>4</sup> Comments of Motorola, Inc., Nov. 30, 2004 at 1 ("Motorola Comments").

<sup>5</sup> Motorola Comments at 3.

<sup>6</sup> *Id.* at 7.

concluded that: (i) the proposed out-of-band emissions levels may not provide adequate protection to TV receivers within the protected contour; (ii) both fixed and portable unlicensed devices should be required to comply with adjacent channel interference protection requirements; and (iii) the possibility of DTV receiver overload should be considered.<sup>7</sup> However, with appropriate refinement to the proposed rules, Motorola argued that allowing unlicensed devices to use the 76-88 MHz, 174-216 MHz, 512-608 MHz and 614-698 MHz would serve the public interest.<sup>8</sup>

Well over 50 parties filed comments responding to the proposals in the NPRM. In general, broadcast television interests expressed great concern over the potential for interference and argued that the Commission should at least defer these actions until the digital television (DTV) transition has concluded.<sup>9</sup> On the other hand, manufacturers of unlicensed devices and wireless internet service providers provided enthusiastic support for the Commission's initiative and argued that only minimum technical requirements are needed to prevent interference.<sup>10</sup>

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<sup>7</sup> *Id.* at i and Appendices A, B.

<sup>8</sup> *Id.* at 4.

<sup>9</sup> *See e.g.*, Joint Comments Of The Association For Maximum Service Television, Inc. And The National Association Of Broadcasters at 3 ("AMST and NAB Joint Comments"); Comments Of Harris Corporation at 3 ("Harris Comments").

<sup>10</sup> *See e.g.*, Comments Of Intel Corporation at 7 ("Intel Comments"); Comments Of Microsoft Corporation at 7 ("Microsoft Comments").



Finally, public safety and private wireless interests expressed concern over the potential ramifications to their operations from unlicensed wireless devices.<sup>11</sup>

As further described herein, Motorola continues to support the Commission's intentions to allow unlicensed devices to use most of the broadcast television spectrum. In so doing, the FCC must ensure that all radio services with a higher allocation status must be protected and not degraded by this action. Sharing issues in bands also used by public safety are the most sensitive and such sharing should not be allowed at this time.

## **II. THE COMMISSION SHOULD PROTECT PUBLIC SAFETY AND OTHER NON-BROADCAST SERVICES OPERATING ON TV CHANNELS 14-20 AND TV CHANNELS 52-69.**

In its opening comments, Motorola opposed the NPRM's tentative plan to allow unlicensed operations on TV channels 14 to 20, *i.e.*, 470 to 512 MHz, which are currently used for public safety and land mobile operations (*i.e.*, PLMRS/CMRS) and broadcast TV operations.<sup>12</sup> Motorola argued that unlicensed underlay operation in TV spectrum that is presently shared by public safety and other critical private and commercial land mobile operations should not be permitted until mechanisms that ensure interference-free unlicensed transmissions are proven to be reliable to the degree necessary to fully protect mission critical operations.

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<sup>11</sup> See *e.g.*, Comments Of Association Of Public-Safety Communications Officials International, Inc., at 2 ("APCO Comments").

<sup>12</sup> Motorola Comments at 5.

APCO shares Motorola's concern. Noting that the Commission-proposed technological controls of the areas in which such devices can operate are untested in real-world environments, APCO argued that public safety cannot be a "guinea pig" for this spectrum sharing technology.<sup>13</sup> APCO therefore urged the Commission to prohibit any unlicensed operations on TV channels 14-20.<sup>14</sup> The County of Los Angeles, which operates a major public safety communications system in the 470-512 MHz band, also opposed the use of this spectrum by devices of a "personal/portable nature" that could be easily transported to areas in which the subject frequencies are used for public safety communications.<sup>15</sup>

Similar sentiments were expressed by the Industrial Telecommunications Association ("ITA") and the Telecommunications Industry Association ("TIA"). ITA expressed its concern over the potential for operators of unlicensed devices to physically relocate into existing land mobile markets and commence operations in close proximity to incumbent stations should the Commission permit manufacturers to incorporate channels 14-20 into equipment nationwide.<sup>16</sup> ITA expressed concern that end-users could modify an unlicensed device beyond manufacturer specifications, increasing the device's signal strength and interference potential to the detriment of incumbent land mobile operations.<sup>17</sup> TIA also urged the FCC to be cautious with respect to

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<sup>13</sup> APCO Comments at 2.

<sup>14</sup> *Id.* at 3.

<sup>15</sup> Comments Of The County Of Los Angeles, California, Nov. 29, 2004, at 2.

<sup>16</sup> Comments Of The Industrial Telecommunications Association, Inc., Nov. 30, 2004, at 2.

<sup>17</sup> *Id.* at 3.

the availability of TV channels 14-20 given their use by public safety agencies for mission critical communications.<sup>18</sup> TIA indicates that the 470-512 MHz band should not be available for unlicensed use, at least initially.<sup>19</sup>

The critical need for uninterrupted public safety communications is indisputable in today's homeland security context. Motorola urges the FCC to ensure that it fully protects public safety by prohibiting the operation of unlicensed devices on frequencies 470-512 MHz; at least until the requisite location technologies are proven to be highly reliable. The remaining portions of the television broadcast allocation will provide an adequate test bed of spectrum to develop and refine these nascent technologies.

Finally, Motorola reiterates its support for the Commission proposal in the NPRM to prohibit wireless devices on channel 52 and above. As the Commission is well aware, this spectrum has been reallocated for commercial and public safety wireless services that will fully deploy at the end of the DTV transition. Given the growth of DTV technology and recent legislative and Commission initiatives, the conclusion of the transition is now expected within the decade. Thus, this spectrum will soon see ubiquitous wireless deployment leaving little opportunity for unlicensed devices. Furthermore, interference mitigation methods in these bands would be hampered by the numerous variations of licensed technology likely to be deployed, making spectrum sensing, if allowed, even more difficult. Because the 698-806 MHz band will

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<sup>18</sup> Comments Of The Telecommunications Industry Association, Nov. 30, 2004, at 4.

<sup>19</sup> *Id.*

soon be home to wide-area wireless communications networks that will make more intensive use of this spectrum than commercial television broadcast, the FCC should adopt its proposal to prohibit the deployment of unlicensed devices in this band.

### **III. TECHNICAL ISSUES**

#### **A. Location Technology and Reliability.**

The NPRM proposed to allow fixed/access unlicensed devices to operate under the same technical provisions as digital transmission systems that operate under Section 15.247 of the rules to permit transmitter output power of up to one watt and the use of higher gain directional antennas.<sup>20</sup> The NPRM also proposed to require that such devices incorporate a method for determining geographic location with a minimum accuracy of 10 meters and noted that GPS receivers could be implemented to determine the geographic coordinates.<sup>21</sup> The NPRM's proposed rule section 15.244(e)(1) states that "the intentional radiator shall incorporate a GPS receiver to determine the geographic coordinates at its location with an accuracy of +/- 10 meters."

In its opening comments, Motorola supported the use of location technology but recommended that the Commission not require a specific technology such as GPS. Rather, the Commission should simply specify location reliability in order to spur innovation by

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<sup>20</sup> NPRM at ¶25.

<sup>21</sup> *Id.* at ¶26. This location determination technology would be integrated with either an internal or external database of broadcast facilities to determine whether the unlicensed device is located far enough outside the protected service contours of licensed stations to avoid causing harmful interference.

encouraging the development of location technologies that provide the requisite level of accuracy.

A number of commenting parties noted that the proposed 10 meter accuracy requirement is overly restrictive and unnecessarily precise. Microsoft, for example, termed the proposed 10-meter accuracy requirement “unduly stringent” and likely to unnecessarily drive up equipment costs.<sup>22</sup> Similarly, the IEEE 802 committee questioned the need for, and practical benefit of, requiring 10 meter accuracy, noting that inexpensive non-augmented, hand-held commercial GPS receivers are only capable of 30 meter accuracy.<sup>23</sup>

Intel argued that a minimum accuracy of 100 meters – as opposed to the 10 meters suggested by the Commission – is adequate to protect licensed services, noting that 100 meters represents only two percent of the protection distance currently needed for 100 milliwatt operation.<sup>24</sup> Moreover, Intel argued that an accuracy requirement of 10 meters would impose an undue cost burden on manufacturers who would likely pass this burden on to consumers by increasing prices for “fixed/access” devices.

These parties share Motorola’s position that the Commission’s rules should not specify a specific location determination technology such as GPS but should only specify the required accuracy. In this regard, Motorola agrees with these commenters that the 10-meter accuracy

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<sup>22</sup> Microsoft Comments at 9.

<sup>23</sup> Comments of IEEE 802 at 9.

<sup>24</sup> Intel Comments at 19.

requirement is unnecessarily precise and agrees with Intel that 100-meter accuracy is adequate to protect licensed services.

We arrive at this conclusion by considering the rate of change of the TV signal due to propagation loss. For example, the rate of change of the F(90,90) predicted field strength using Longley-Rice is 0.06 dB/100m at a frequency of 200 MHz<sup>25</sup>. Thus, an unlicensed device that had a 100 m location uncertainty would calculate the F(90,90) field strength within 0.06 dB, which is for all practical purposes more than sufficient for determining adjacent channel transmit power levels.

#### **B. Out of band emissions.**

In its opening comments, Motorola stated its belief that the proposed out-of-band emission requirements for unlicensed devices will not comport with the protection requirements for television operations under some scenarios.<sup>26</sup> Based on its internal technical analyses, Motorola indicated that when operating inside a grade B contour with co-polarized unlicensed devices, the out-of-band emissions at Part 15.209(a) levels, under worst-case conditions, are inadequate by more than 35 dB.<sup>27</sup> Also, the use of a more conservative Monte Carlo analysis indicated that the Part 15.209(a) field strength levels exceed the specified D/U requirements by

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<sup>25</sup> It is assumed that the broadcast transmit tower is at a height of 500 meters, the receive antenna is at a height of 9 meters and the terrain has a 30 meters variation. The rate of change of propagation loss at a distance of 60 km to 70 km from the broadcast tower is 3 dB/5 km or 0.06 dB/100 m. A similar result is found using the FCC F-curve calculator for F(50,90) curves and assuming the broadcast transmitter at a height of 500 meters (HAAT) with power of 100 kW ERP with nominal terrain variation. Under these assumptions at distances of 60-70 km from the broadcast tower the rate of change of the TV signal is 5.3 dB/10 km or 0.053 dB/100 m.

<sup>26</sup> Motorola Comments at 12.

<sup>27</sup> *Id.* See also, Appendix A, Motorola Comments.

over 16 dB.<sup>28</sup> Based on the scenarios analyzed, Motorola stated that section 15.209(a) emission levels do not provide adequate protection to TV receivers within the protected contour of adjacent TV stations and that further analysis is warranted.<sup>29</sup>

Motorola also took issue with the NPRM's proposal that personal/portable devices be subject only to co-channel protection criteria and not consider adjacent channel operations, as is required for fixed/access devices.<sup>30</sup> Instead, Motorola recommended that when a portable device operates inside a protected contour on an adjacent channel, the maximum transmit power be reduced to comply with the adjacent channel D/U requirement.<sup>31</sup> Motorola recommended that the following maximum EIRPs for unlicensed devices would adequately protect adjacent channel operations at the grade B contour: -17 dBm for Low VHF, -9 dBm for Upper VHF, and -4 dBm for UHF.<sup>32</sup>

Other parties suggested that the FCC's proposals are adequate or even unnecessarily restrictive. While the IEEE 802 committee supported the Commission's use of Section 15.209,<sup>33</sup> Microsoft argued that these requirements "could eliminate the possibility of using the TV spectrum for broadband services."<sup>34</sup> Microsoft did not present any detailed technical analysis to

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<sup>28</sup> *Id.*

<sup>29</sup> *Id.*

<sup>30</sup> *Id.* at 14.

<sup>31</sup> *Id.*

<sup>32</sup> *Id.*

<sup>33</sup> Comments of IEEE 802 at 17.

<sup>34</sup> Microsoft Comments at 26.

support this assertion, but instead extrapolated from existing unlicensed policy and rules to determine that the provisions of Section 15.247(c), which applies to unlicensed operation in the 900 MHz, 2.4 GHz and 5 GHz ISM bands, would be adequate protection for adjacent channel broadcast operations.<sup>35</sup>

Intel argued that Part 15.209 emissions standards should specify the emissions at frequencies well removed from the intended channel and would be unduly restrictive if applied to the adjacent channel.<sup>36</sup> Intel provided analysis that attempts to demonstrate that in order to protect TV channels other than the co-channel on which the device is operating, the out of band emissions should be a total of 49 dB below the peak power at which the unlicensed transmitter is operated.<sup>37</sup>

Motorola has concerns that the out-of-band emissions requirements for unlicensed devices will have a harmful impact to land mobile operations operating in the 470-512 MHz band and believes that emissions levels into these bands be no more than those permitted under the standards detailed in Section 15.209. In establishing out-of-band emissions requirements for new services and devices, the Commission must first ensure the protection of incumbent operations and then consider the impact on the designs and implementation of the new

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<sup>35</sup> *Id.* at 27.

<sup>36</sup> Intel Comments at 7. *See also*, Intel Comments at Appendix A.

<sup>37</sup> Intel Comments at Appendix B, page 1. Motorola notes that the Intel analysis assumes that the emissions are in terms of transmit power level and not peak transmit power (e.g., Figure 2 in Appendix A of Intel's comments indicates that the emission levels would be attenuated 49 dB below the transmit power level.).



technology. Motorola submitted studies demonstrating that the proposed requirements based on Section 15.209 are inadequate by at least 35 dB when considering worst-case deployment scenarios. While the Commission must decide whether it needs to protect against worst-case scenarios that might be extremely rare in practice, Motorola's analysis shows that additional protection should strongly be considered. The Commission does no favors for the wireless industries if it establishes technical standards that result in significant interference to incumbent operations. Motorola urges the Commission to review its analysis and adopt emissions levels that adequately protect all incumbent licensees.

Motorola also reiterates its recommendation that mobile and portable devices should be subject to adjacent channel interference standards. This recommendation was supported by IEEE 802, which stated that "if the Commission elects to move forward to draft Rules for personal/portable devices, it should ensure that they do not operate co-channel within the Grade B contour of a licensed television station and comply with the same adjacent channel D/U ratios as proposed in the NPRM for Fixed/Access devices."<sup>38</sup>

### **C. Interference Mitigation Methods.**

The NPRM sought comment on three methods that could be used to determine whether a portion of the TV band is unused at a specific time and/or location: 1) when installed or moved to a new location, the location coordinates of an unlicensed device could be determined by a professional installer or by using geo-location technology such as GPS incorporated within the

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<sup>38</sup> Comments of IEEE 802 at 7.

device to determine from either an internal or external database whether the unlicensed device is located far enough outside the protected service contours of licensed stations to avoid causing harmful interference, 2) an unlicensed device could receive information transmitted by an external source such as a broadcast station or another unlicensed transmitter indicating which channels are available at its geographic location, and 3) incorporate sensing capabilities in the unlicensed device to detect whether other transmitters are operating in an area.<sup>39</sup>

In general, Motorola believes that all of these options offer promise for protecting incumbent radio services. In its opening comments, Motorola identified several issues associated with each of these approaches. Therefore, the Commission needs to consider a requirement that each product design must have a “fail safe” mechanism to avoid unintended operation under any method used to protect other operations.

### **1. Database/Professional installation.**

While supportive of this methodology, Motorola expressed concern about the accuracy of broadcast facilities databases that would be used by fixed/access devices to determine the frequencies that need to be protected by location.<sup>40</sup> These same concerns were echoed by IEEE 802, which stated that these questions in accuracy raised concerns about the viability of interference protection mechanisms that rely solely, or primarily, on a database-driven

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<sup>39</sup> NPRM at ¶20. The Commission only specifically invited comment on spectrum sensing for fixed/access stations. NPRM at ¶20, ¶28.

<sup>40</sup> Motorola Comments at 10.

approach.<sup>41</sup> Harris also recognized the need for up-to-date information and thus recommended that fixed/access unlicensed stations should be required to obtain weekly updates of the broadcast database and that failure to receive such updates would cause the device to automatically shut-down.<sup>42</sup> Similarly, Harris also suggested that a fixed/access device should be required to shut down automatically if it fails to discern its location for 10 contiguous minutes.<sup>43</sup>

Motorola shares these concerns and recommendations, although a required shut down after a 10 minute loss of location information is extreme. Confirming a location fix on a once-per-day basis should be more than sufficient for fixed/access equipment to satisfy the Commission's ultimate responsibility to institute effective fail-safe methods that prevent devices from being used in a manner for which they were not intended.

A number of parties question whether the proposed requirement for professional installation of fixed/access devices is enforceable.<sup>44</sup> While Motorola supports this concept, it agrees that the FCC must clearly define the required skills to perform this function to avoid human error that could result in interference.

## **2. Beacons.**

Many commenting parties believe that beacons or control channels designed to steer unlicensed devices to usable frequencies in a particular location is a viable approach to avoiding

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<sup>41</sup> Comments of IEEE 802 at 7.

<sup>42</sup> Harris Comments at 8.

<sup>43</sup> *Id.* at 7.

<sup>44</sup> See e.g., Harris Comments at 8; Comments of Tropos Networks at 6.

broadcast station interference. Microsoft noted, however, that there are network architectures that would be at odds with a control channel protocol and therefore urged the FCC to not mandate this approach.<sup>45</sup>

Motorola supports the use of beacons and control signals but believes that the Commission should establish rules for their use. Most importantly, the concept should be one of a positive acknowledgement, where the beacon provides the device with the frequencies that are available for use in a particular area. Motorola urges the Commission to reject the proposal of WirelessUnleashed<sup>46</sup> that would allow unlicensed devices to transmit unless a control signal is received. This would shift the onus of interference protection to the incumbent licensees by requiring them to install a beacon to ensure that their signals are indeed protected from unlicensed operations.

Similar to the recommendation that fixed/access devices not require constant location fixes to maintain operation, but rather update on a once-per-day basis, we further recommend that personal/portables not be required to constantly monitor the beacon signal. To maintain a constant beacon monitor, the personal/portable device would have to dedicate a receiver resource specifically for this purpose, and that receiver resource would have to reject the device's transmissions without desensing. To maintain constant detection of the beacon signal, the device may further require diversity reception if the beacon signal is received over a fading channel.

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<sup>45</sup> Microsoft Comments at 12.

<sup>46</sup> Comments of WirelessUnleashed at 15, 16.

Having the device's primary receiver revisit the beacon signal for short dwells on a regular basis should be sufficient to ensure non-interference. A maximum revisit time would need to be specified. If portables could be mobile at 60 mph, once per minute monitoring could result in 1 mile changes, while monitoring every 4 seconds or so could result in a maximum location change of about 100 m, a value discussed previously pertaining to location resolution.

### **3. Spectrum Sensing.**

In its comments, Motorola expressed cautious support for the concept of spectrum sensing to avoid interference to incumbent operations.<sup>47</sup> However, a fundamental principle of exclusively observation-based cognitive operation is that knowledge of an unlicensed device's proximity to a primary receiver (in this case the protected contour of the incumbent), the corresponding path loss, and the contributions from other interfering transmitters at the primary receiver, are necessary to determine the opportunity for unlicensed transmissions. As we stated in our comments and reiterate here, "[w]e understand that proximity can be inferred from sensed power measurements, but the reliability of this method requires further study."<sup>48</sup> Although the technology appears promising, Motorola recommended that the Commission support further research and experimentation with the technology, but not permit spectrum sensing until its reliability is proven.

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<sup>47</sup> Motorola Comments at 15.

<sup>48</sup> *Id.* at note 24.

Intel presented a sensing-based method for determining an appropriate personal/portable transmitter power that would satisfy adjacent channel D/U ratios where protection is provided by 1) specifying a minimum detectable pilot level which is significantly lower than the usable signal level for DTV reception, and 2) setting the transmitter power at a sensed-power-plus-offset level that accounts for a minimum practical path loss.<sup>49</sup> Motorola believes that this methodology has promise, but uncertainties in propagation and sensor sensitivity create the potential for excessive co-channel interference if the channel is incorrectly designated as vacant. We note that large differences in propagation can exist between the wanted signal path for TV operation (at receive antenna heights of 5-10 m) and the sensing signal path (a sensing receive antenna with 0 dBi gain at 1-2 m in height). These differences can result in a device making an incorrect decision in determining the vicinity of a TV receiver and thus create unacceptable interference levels. Our major concern is that the Commission must ensure that protection can be afforded to the incumbents by such an approach and therefore, we believe that spectrum sensing should not be permitted until the methods are proven to be reliable by both research studies and field testing.

Adaptrum commented on the advantages of multiple sensor networks for detection of the presence of the primary signal.<sup>50</sup> The benefits of multiple sensing nodes sharing sensing information have already been recognized and proposed for use in cognitive networks. However, there are fundamental issues such as the physical characteristics of the network (*e.g.*,

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<sup>49</sup> Intel Comments at 3, Appendix A.

<sup>50</sup> Comments of Adaptrum, Inc.

number of nodes, geographic extent and distribution), the required detection threshold, and transmit power control rules, that remain to be addressed before regulations can be crafted.

#### **IV. OTHER TOPICS**

##### **A. Higher Power operations.**

In its initial comments, Motorola urged the FCC to consider allowing professionally installed, higher-powered unlicensed fixed operations of up to 25 W in rural and remote areas provided that such operations comply with all interference protection requirements of the licensed services.<sup>51</sup> Other commenters also supported the concept of allowing higher powered devices including Microsoft, CW Lab, and WirelessUnleashed.

Allowing higher powered devices will facilitate the deployment of broadband services to rural and remote areas by reducing the costs for the required infrastructure. Provided that the same interference protection ratios are afforded to incumbent operations, this proposal furthers the public interest without any harm to other spectrum users.

##### **B. Standards.**

The NPRM seeks comment on the need for voluntary standards to facilitate shared unlicensed use of the TV broadcast bands, such as those developed by IEEE 802.11 for operation in the other bands used by unlicensed devices. If voluntary standards are necessary, the Commission seeks comment on what role the FCC should adopt to make certain that the standards remain current and support innovation.

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<sup>51</sup> Motorola Comments at 5.

In response to this request, Microsoft urged the Commission to become actively engaged in industry-developed standards that hold value not only for easing sharing among unlicensed devices, but also because techniques embodied in a voluntary standard can facilitate interference avoidance.<sup>52</sup> Microsoft argued that “[i]t would be a true public policy tragedy if the vacant TV channels suffered from the proverbial tragedy of the commons; if the highly useful spectrum the Commission proposes to re-purpose in this proceeding were rendered “junk spectrum” by excessive operation of “impolite” devices.”<sup>53</sup>

Motorola shares Microsoft’s concern about a proliferation of unfriendly or incompatible devices. In its opening comments, Motorola stated that the Commission should support the development of voluntary standards for unlicensed operations in the TV bands, yet it should not regulate compliance with a particular interoperability standard so as to not rule out innovative uses of the band by non-standards -based approaches. Thus, the FCC should only specify minimum operating requirements to enable shared use of the bands, as it has sought to do in proposed rule section 15.244, and let voluntary standards bodies (like IEEE 802) set interoperability guidelines. The FCC should monitor the standards setting process to ensure that developments are in fact occurring.

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<sup>52</sup> Microsoft Comments at 17.

<sup>53</sup> *Id.*



### **C. Enforcement.**

In its comments, Motorola stated that registration of fixed/access base stations and personal/portable beacon transmitters with a frequency coordinator would be sufficient to aid enforcement and enable identification of interfering devices.<sup>54</sup> Motorola opposed the NPRM proposal to require the low power personal devices to periodically transmit an identification signal on the basis that the interference protection mechanisms proposed by the FCC (*i.e.*, geolocation and control channel) and registration of unlicensed infrastructure with a frequency coordinator provides sufficient interference protection.

Other parties, such as Harris, support the Commission's proposal to require unlicensed devices to automatically and periodically transmit a unique identification signal.<sup>55</sup> Harris urges the Commission to require that unlicensed devices transmit an identification signal that includes the manufacturer name and model number, its FCC identifier, and its unique serial number at least every 30 seconds.

Before allowing unlicensed devices to occupy the broadcast television allocation, the FCC must be certain that interference mitigation techniques exist to prevent interference to licensed services with a very high degree of reliability. Assuming that equipment designs pass this threshold test, requiring devices to send automatic identifications every 30 seconds is regulatory overkill. A 30 second identification signal will require a standardized modulation

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<sup>54</sup> Motorola Comments at 10.

<sup>55</sup> Harris Comments at 9.

signal that could either retard innovative uses or increase costs on these devices. It also would result in inefficient spectrum use as millions of identifications for properly operating systems would be transmitted every day.

**D. Wireless Microphones.**

The NPRM expressed the Commission's belief that unlicensed devices do not represent an interference threat to broadcast wireless microphones because wireless microphones are permitted relatively high output power given the range over which they typically operate (the maximum permitted output power of these devices is 50 milliwatts in the VHF band and 250 milliwatts in the UHF band). Also, wireless microphones are used in locations such as theaters and sports arenas where the operating range would typically be hundreds of feet at the most, so operation at the power levels permitted in the rules results in a significant signal level at the wireless microphone receiver. Finally, the NPRM noted that the vast majority of wireless microphones are FM receivers that exhibit a "capture effect" in which they respond to only the strongest signal received on a frequency and reject any weaker interfering signals.

In its comments, Shure detailed several issues with the Commission's assumptions.<sup>56</sup> In summary, Shure provided analysis that concludes the following:

- The majority of wireless microphones do not use the maximum power allowed under Part 74 of the Commission's Rules. Less than 4% (2 models) operate at the FCC maximum power level of 250 mW, while the vast majority of models, 85% (49 models), operate between 10 mW and 50 mW of conducted output power.

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<sup>56</sup> Comments of Shure Incorporated at 9-14.

- Even at relatively short distances, wireless microphones will experience co-channel interference from unlicensed devices. Even at an operating range of 100 meters, the link margin for these systems is relatively low whereas the minimum Desired-to-Undesired (D/U) signal ratio for professional audio is 20 dB.
- Because FM capture effect is proportional to the modulation level (i.e., occupied bandwidth), wireless microphones occupying 200 kHz channels only derive a moderate amount of benefit from the FM capture effect and cannot reject interference at D/U levels of less than 20 dB.

Motorola believes that Shure and other commenters have made a strong case that wireless microphones are threatened by widespread deployment of unlicensed devices if appropriate safeguards are adopted. In addition to the interference mitigation techniques already under consideration, Shure recommends that the Commission designate 2 VHF High Band TV channels (7-13) and 4 UHF TV channels in each television market as exempt from unlicensed device operation so that wireless microphones may operate free from interference.

Motorola supports a solution that involves the reservation of TV channels for wireless microphones over unlicensed use. Shure's proposal that 2 VHF channels and 4 VHF channels be identified for such purpose appears to meet general requirements. However, the Commission should also consider whether special news events that demand additional spectrum for wireless microphones will require additional coordination for the short-term identification of protected spectrum for wireless microphones.

#### **E. Timing.**

Motorola disagrees with the suggestions of broadcasting interests that the Commission must defer consideration of this proceeding until after the DTV transition has concluded. In Motorola's view, even in the midst of the DTV transition, the broadcast television allocation is

not a dynamically changing frequency environment. Stations that do change channels do so only after months of advanced notice and prior FCC approval. This environment is well within the ability of data base managers to monitor to enable the appropriate consideration of all incumbent licensees.

**F. Use of Adjacent TV channels.**

The IEEE 802 takes issue with proposed rule Section 15.244 that allows the use of contiguous TV channels for intentional radiators. IEEE 802 believes that multiple 6 MHz TV channels should be allowed, but that each 6 MHz channel should be independent from a modulation point of view. Under the IEEE 802's view, the use of more than one TV channel would be possible "as long as persistent channel bonding is not used."

Motorola supports the Commission's original draft of the rule and believes that the IEEE 802's proposal would unnecessarily limit technology. Especially in rural areas, the promise of wide swaths of virgin spectrum capable of supporting broadband applications should not be unnecessarily constrained by arbitrary technical restrictions.

**V. CONCLUSION.**

The Commission should adopt rules that provide for expanded use of the television broadcast spectrum by unlicensed devices. Such use will further the public interest by providing for more intensive use of valuable spectrum and will result in a plethora of new broadband services to consumers. The Commission must, however, develop realistic technical standards

and operational requirements that ensure to high degree of certainty that unlicensed devices will not interfere with incumbent operations.

Respectfully submitted,

MOTOROLA, INC.

By: /S/ Steve B. Sharkey  
Steve B. Sharkey  
Director, Spectrum and Standards Strategy  
1350 I Street, NW, Suite 400  
Washington, DC 20005-3305  
202 371-6953

/S/ Robert D. Kubik  
Robert D. Kubik, Ph. D.  
Manager, Spectrum and Regulatory Policy  
1350 I Street, NW, Suite 400  
Washington, DC 20005-3305  
202 371-6940

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